

FUNCTIONAL MATERIALS FOR USE IN OPTICAL SYSTEMS

CLAIMS

We claim:

- 1 1. A functional optical material for use in an optical system, comprising:
 - 2 (a) a polymer selected from the group comprising,
 - 3 (1) a thermoplastic polymer;
 - 4 (2) a thermosetting polymer; and
 - 5 (3) a combination of thermoplastic and thermosetting polymers;
 - 6 wherein said thermoplastic and/or thermosetting polymers contain
 - 7 carbon-hydrogen and/or carbon-fluoride functionality; and
 - 8 (b) one or more optically active chromophores blended and/or copolymerized
 - 9 with said polymer;
 - 10 (c) a compatibilizer copolymerized with said polymer of step (a), having one
 - 11 or more pendant groups selected from the group consisting of nitriles, esters,
 - 12 aromatics; fluorinated esters, and fluorinated aromatics; and
 - 13 (d) an adhesion promoter copolymerized with said polymer of step (a), having
 - 14 one or more pendant groups selected from the group consisting of nitriles,
 - 15 silanes, fluorinated silanes, organic acids; fluorinated organic acids, alcohols,
 - 16 fluorinated alcohols, amides, and amines; and
 - 17 wherein when a compatibilizer with one particular pendant group is selected,
 - 18 an adhesion promoter with a different pendant group is selected.
- 1 2. The functional optical material according to Claim 1, wherein said
 - 2 thermoplastic and/or thermosetting polymer is selected from the group
 - 3 consisting of acrylics /methacrylics; copolymers of acrylic acid esters,
 - 4 methacrylic acid esters, and other single unsaturated monomers; polyesters;
 - 5 polyurethanes; polyimides; polyamides; polyphosphazenes; epoxy resin; and
 - 6 hybrid (organic-inorganic) or nanocomposite polyester polymers.

1 3. The functional optical material according to Claim 1, wherein said
2 thermoplastic polymer is selected from the group consisting of
3 acrylics/methacrylics (copolymers of esters of acrylic and methacrylic acid
4 where the alcohol portion of the ester can be based on hydrocarbon, or
5 partially or fully fluorinated alkyl chains); polyesters (where the diacid or diol
6 can contain carbon-hydrogen aliphatic, aromatic or carbon-fluorine
7 functionality); polyurethanes (where the diisocyanate can be aliphatic or
8 aromatic and the diol can contain carbon-hydrogen or carbon-fluorine
9 functionality); polyimides where the acid, amine, or diamine can be partially
10 or fully fluorinated; polyamides (where the diacid or diamine can contain
11 carbon – hydrogen aliphatic, aromatic or carbon-fluorine functionality);
12 polyphosphazenes (where the polyphosphazene backbone structure can
13 contain fluorinated aromatic or aliphatic functional groups, as well as, carbon-
14 hydrogen functionality); epoxy resin (where the epoxy resin can contain
15 carbon-hydrogen or carbon-fluorine functionality⁰ which can further be
16 reacted with diacids or anhydrides (that also contain carbon-hydrogen or
17 carbon-fluorine functionality); and hybrid (organic-inorganic) or
18 nanocomposite polyester polymers (where the polyester component consists
19 of aliphatic, aromatic carbon hydrogen or carbon-fluorine functionality and the
20 inorganic components are based on silane or organometallic materials such as
21 titanates, zirconates and other multivalent metal organics).

1 4. The functional optical material according to Claim 1, wherein functional
2 optical material has a glass transition temperature above 100°C.

1 5. The functional optical material according to Claim 1, wherein said
2 functional optical material has a refractive index value of less than about 1.5.

1 6. The functional optical material according to Claim 1, wherein said
2 functional optical material has a refractive index value of greater than or
3 equal to about 1.5.

- 1 7. The functional optical material according to Claim 1, wherein said
2 functional optical material has between 0.1 and 10% of a promoter having an
3 adhesive promotion group, or combination of adhesive promotion groups.
- 1 8. The functional optical material according to Claim 1, wherein said
2 compatibilizer has nitrile, ester, fluorinated ester, and fluorinated aromatic
3 groups.
- 1 9. The functional optical material according to Claim 1, wherein said
2 adhesion promoter has nitrile, silane, fluorinated silane, organic acid;
3 fluorinated organic acid, alcohol, and fluorinated alcohol groups.
- 1 10. The functional optical material according to Claim 1, wherein
2 monomers are included that provide water resistance by having styrene
3 and/or cycloaliphatic groups.
- 1 11. The functional optical material according to Claim 1, wherein said
2 functional optical material has between 0.1 and 20% of one or more
3 compatibilizers for said one or more chromophores.
- 1 12. The functional optical material according to Claim 1, wherein there is
2 less than 5 wt.% of hydrogen in the monomer repeat unit and other units of
3 the functional optical material).
- 1 13. The functional optical material according to Claim 1, wherein said
2 functional optical material has less than 2% water absorption according to a
3 24 hour water immersion test.
- 1 14. The functional optical material according to Claim 1, wherein said
2 functional optical material requires less than 100 volts per micron of film
3 thickness to pole said functional optical material.

1 15. The functional material according to Claim 1, wherein a compatibilizer
2 is selected having a nitrile group, and an adhesion promoter is selected
3 having a silane group.

1 16. The functional optical material according to Claim 1, wherein said one
2 or more optically active chromophores is (are) selected from the group
3 consisting of a substituted aniline, substituted azobenzene, substituted
4 stilbene, or substituted imine.

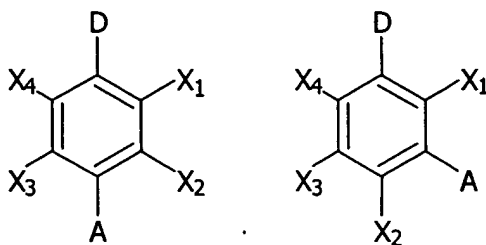
1 17. The functional optical material according to Claim 16, wherein said one
2 or more optically active chromophores are selected from substituted anilines
3 comprising:

4 first substituted anilines,

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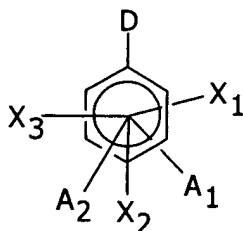
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10 Wherein D = donor = $-\text{NH}_2$, $-\text{N}(\text{CH}_3)_2$, $-\text{N}(\text{CH}_2\text{CH}_3)_2$, or $-\text{N}(\text{Y})_2$ where Y =
11 alkyl alcohols, alkyl (hydrocarbon fluorocarbon) esters, or alkyl silane
12 derivatives;

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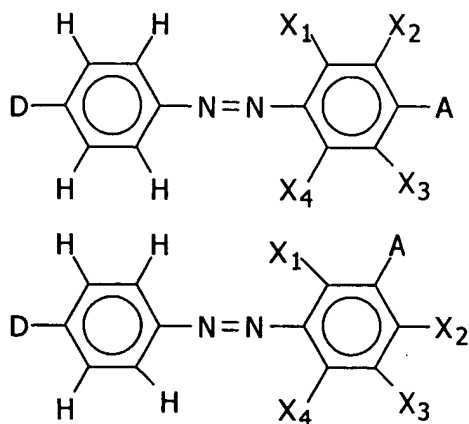
14 A = acceptor = $-\text{NO}_2$, $-\text{C}(\text{CN})\text{C}(\text{CN})_2$, or $-\text{N}=\text{C}(\text{R}_1)(\text{R}_2)$, wherein $\text{R}_1 = \text{CF}_3$,
15 C_2F_5 , $\text{C}_n\text{F}_{2n+1}$, $\text{R}_2 = \text{H}$, CH_3 , CF_3 , C_2F_5

16 wherein when $A = -NO_2$, or $-C(CN)C(CN)_2$, then X_1, X_2, X_3, X_4 are each
 17 independently selected from the group -F and -H, and at least one -F is
 18 selected, and when $A = -N=C(R_1)(R_2)$, wherein $R_1 = CF_3, C_2F_5, C_nF_{2n+1}$, $R_2 =$
 19 H, CH_3, CF_3, C_2F_5 , then X_1, X_2, X_3, X_4 are each independently selected from
 20 the group -F and -H;
 21
 22 or second substituted anilines,

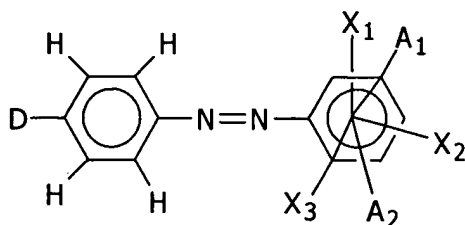


23
 24 Wherein $D = \text{donor} = -NH_2, -N(CH_3)_2, -N(CH_2CH_3)_2$, or $-N(Y)_2$ where $Y =$
 25 alkyl alcohols, alkyl (hydrocarbon or fluorocarbon) esters, or alkyl silane
 26 derivatives;
 27
 28 $A_1 = \text{primary acceptor} = -NO_2, -C(CN)C(CN)_2$, or $-N=C(R_1)(R_2)$, where
 29 $R_1 = CF_3, C_2F_5, C_nF_{2n+1}$, $R_2 = H, CH_3, CF_3, C_2F_5$
 30
 31 $A_2 = \text{secondary acceptor} = -CN$, or $-CF_3$
 32
 33 wherein X_1, X_2, X_3 are each independently selected from the group -F and -H;
 34
 35 and wherein A_1 can be the same as A_2 , wherein two identical or different
 36 acceptors may be selected from group A_1 or two identical or different
 37 acceptors may be selected from group A_2 , so that when acceptors are
 38 selected from $-NO_2, -C(CN)C(CN)_2, -CN$, or $-CF_3$, then X_1, X_2, X_3 are each
 39 independently selected from the group -F and -H, and at least one -F is
 40 selected; and if at least one acceptor is selected as $-N=C(R_1)(R_2)$, where
 41 $R_1 = CF_3, C_2F_5, C_nF_{2n+1}$, $R_2 = H, CH_3, CF_3, C_2F_5$, then X_1, X_2, X_3 are each
 42 independently selected from the group -F and -H.

- 1 18. The functional optical material according to Claim 16, wherein said one
 2 or more optically active chromophores is (are) selected from substituted
 3 azobenzenes comprising:
 4 first substituted azobenzenes,



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 6
 7 Wherein D = donor = $-\text{NH}_2$, $-\text{N}(\text{CH}_3)_2$, $-\text{N}(\text{CH}_2\text{CH}_3)_2$, or $-\text{N}(\text{Y})_2$ where Y =
 8 alkyl alcohols, alkyl (hydrocarbon fluorocarbon) esters, or alkyl silane
 9 derivatives;
 10
 11 A = acceptor = $-\text{NO}_2$, $-\text{C}(\text{CN})\text{C}(\text{CN})_2$, or $-\text{N}=\text{C}(\text{R}_1)(\text{R}_2)$, wherein $\text{R}_1 = \text{CF}_3$,
 12 C_2F_5 , $\text{C}_n\text{F}_{2n+1}$, $\text{R}_2 = \text{H}$, CH_3 , CF_3 , C_2F_5
 13 wherein when A = $-\text{NO}_2$, or $-\text{C}(\text{CN})\text{C}(\text{CN})_2$, then X_1 , X_2 , X_3 , X_4 are each
 14 independently selected from the group -F and -H, and at least one -F is
 15 selected, and when A = $-\text{N}=\text{C}(\text{R}_1)(\text{R}_2)$, wherein $\text{R}_1 = \text{CF}_3$, C_2F_5 , $\text{C}_n\text{F}_{2n+1}$, $\text{R}_2 =$
 16 H , CH_3 , CF_3 , C_2F_5 , then X_1 , X_2 , X_3 , X_4 are each independently selected from
 17 the group -F and -H;
 18
 19 or second substituted azobenzenes,
 20
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24 Wherein D = donor = $-\text{NH}_2$, $-\text{N}(\text{CH}_3)_2$, $-\text{N}(\text{CH}_2\text{CH}_3)_2$, or $-\text{N}(\text{Y})_2$ where Y =
 25 alkyl alcohols, alkyl (hydrocarbon or fluorocarbon) esters, or alkyl silane
 26 derivatives;

27

28 primary acceptor = $-\text{NO}_2$, $-\text{C}(\text{CN})\text{C}(\text{CN})_2$, or $-\text{N}=\text{C}(\text{R}_1)(\text{R}_2)$, where $\text{R}_1 =$
 29 CF_3 , C_2F_5 , $\text{C}_n\text{F}_{2n+1}$, $\text{R}_2 = \text{H}$, CH_3 , CF_3 , C_2F_5

30

31 secondary acceptor = $-\text{CN}$, or $-\text{CF}_3$

32

33 wherein if A_1 and A_2 are both primary acceptors selected from $-\text{NO}_2$, or
 34 $-\text{C}(\text{CN})\text{C}(\text{CN})_2$, then X_1 , X_2 , X_3 are each independently selected from -F and -
 35 H, but at least one -F must be selected;

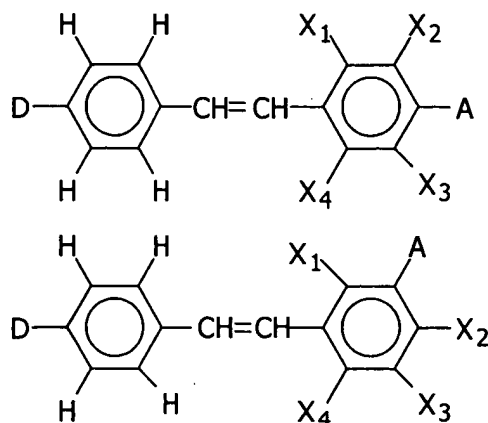
36 wherein if A_1 and A_2 are both secondary acceptors selected from $-\text{NO}_2$, or
 37 $-\text{C}(\text{CN})\text{C}(\text{CN})_2$, then X_1 , X_2 , X_3 are each independently selected from -F and -
 38 H, but at least one -F must be selected;

39 wherein if A_1 and/or A_2 are selected from the primary acceptor $-\text{N}=\text{C}$
 40 $(\text{R}_1)(\text{R}_2)$, where $\text{R}_1 = \text{CF}_3$, C_2F_5 , $\text{C}_n\text{F}_{2n+1}$, $\text{R}_2 = \text{H}$, CH_3 , CF_3 , C_2F_5 , then X_1 , X_2 , X_3
 41 are each independently selected from -F and -H; and

42 wherein if A_1 is selected from any primary acceptor, and A_2 is selected from
 43 any secondary acceptor, then X_1 , X_2 , X_3 are each independently selected from
 44 -F and -H.

1 19. The functional optical material according to Claim 16, wherein said one
 2 or more optically active chromophores is (are) selected from substituted
 3 stilbenes comprising:

4 first substituted stilbenes,



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7 Wherein D = donor = $-\text{NH}_2$, $-\text{N}(\text{CH}_3)_2$, $-\text{N}(\text{CH}_2\text{CH}_3)_2$, or $-\text{N}(\text{Y})_2$ where Y =
8 alkyl alcohols, alkyl (hydrocarbon fluorocarbon) esters, or alkyl silane
9 derivatives;

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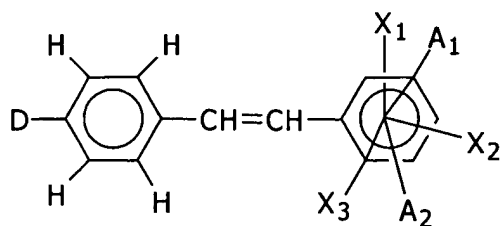
11 A = acceptor = $-\text{NO}_2$, $-\text{C}(\text{CN})\text{C}(\text{CN})_2$, or $-\text{N}=\text{C}(\text{R}_1)(\text{R}_2)$, wherein $\text{R}_1 = \text{CF}_3$,
12 C_2F_5 , $\text{C}_n\text{F}_{2n+1}$, $\text{R}_2 = \text{H}$, CH_3 , CF_3 , C_2F_5

13 wherein when A = $-\text{NO}_2$, or $-\text{C}(\text{CN})\text{C}(\text{CN})_2$, then X_1 , X_2 , X_3 , X_4 are each
14 independently selected from the group -F and -H, and at least one -F is
15 selected, and when A = $-\text{N}=\text{C}(\text{R}_1)(\text{R}_2)$, wherein $\text{R}_1 = \text{CF}_3$, C_2F_5 , $\text{C}_n\text{F}_{2n+1}$, $\text{R}_2 =$
16 H , CH_3 , CF_3 , C_2F_5 , then X_1 , X_2 , X_3 , X_4 are each independently selected from
17 the group -F and -H;

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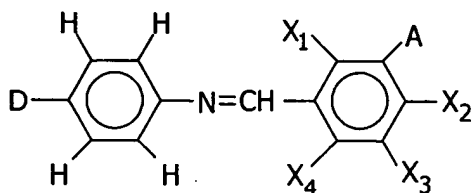
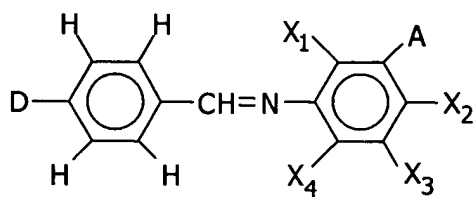
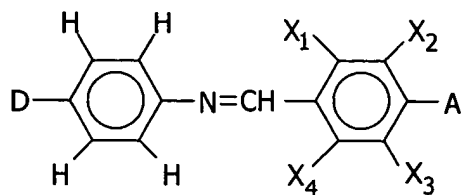
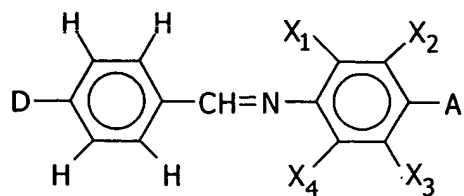
19 or second substituted stilbenes,

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21 Wherein D = donor = —NH_2 , $\text{—N(CH}_3)_2$, $\text{—N(CH}_2\text{CH}_3)_2$, or —N(Y)_2 where Y =
 22 alkyl alcohols, alkyl (hydrocarbon or fluorocarbon) esters, or alkyl silane
 23 derivatives;
 24
 25 primary acceptor = —NO_2 , —C(CN)C(CN)_2 , or $\text{—N=C (R}_1\text{)(R}_2\text{)}$, where $\text{R}_1 =$
 26 CF_3 , C_2F_5 , $\text{C}_n\text{F}_{2n+1}$, $\text{R}_2 = \text{H}$, CH_3 , CF_3 , C_2F_5
 27
 28 secondary acceptor = —CN , or —CF_3
 29
 30 wherein if A_1 and A_2 are both primary acceptors selected from —NO_2 , or
 31 —C(CN)C(CN)_2 , then X_1 , X_2 , X_3 are each independently selected from -F and -
 32 H, but at least one -F must be selected;
 33 wherein if A_1 and A_2 are both secondary acceptors selected from —NO_2 , or
 34 —C(CN)C(CN)_2 , then X_1 , X_2 , X_3 are each independently selected from -F and -
 35 H, but at least one -F must be selected;
 36 wherein if A_1 and/or A_2 are selected from the primary acceptor —N=C
 37 $\text{(R}_1\text{)(R}_2\text{)}$, where $\text{R}_1 = \text{CF}_3$, C_2F_5 , $\text{C}_n\text{F}_{2n+1}$, $\text{R}_2 = \text{H}$, CH_3 , CF_3 , C_2F_5 , then X_1 , X_2 , X_3
 38 are each independently selected from -F and -H; and
 39 wherein if A_1 is selected from any primary acceptor, and A_2 is selected from
 40 any secondary acceptor, then X_1 , X_2 , X_3 are each independently selected from
 41 -F and -H.

1 20. The functional optical material according to Claim 16, wherein said one
 2 or more optically active chromophores is (are) selected from substituted
 3 imines comprising:
 4 first substituted imines,
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8 Wherein D = donor = $-\text{NH}_2$, $-\text{N}(\text{CH}_3)_2$, $-\text{N}(\text{CH}_2\text{CH}_3)_2$, or $-\text{N}(\text{Y})_2$ where Y =

9 alkyl alcohols, alkyl (hydrocarbon fluorocarbon) esters, or alkyl silane

10 derivatives;

11

12 A = acceptor = $-\text{NO}_2$, $-\text{C}(\text{CN})\text{C}(\text{CN})_2$, or $-\text{N}=\text{C}(\text{R}_1)(\text{R}_2)$, wherein $\text{R}_1 = \text{CF}_3$,

13 C_2F_5 , $\text{C}_n\text{F}_{2n+1}$, $\text{R}_2 = \text{H}$, CH_3 , CF_3 , C_2F_5

14 wherein when A = $-\text{NO}_2$, or $-\text{C}(\text{CN})\text{C}(\text{CN})_2$, then X_1 , X_2 , X_3 , X_4 are each

15 independently selected from the group -F and -H, and at least one -F is

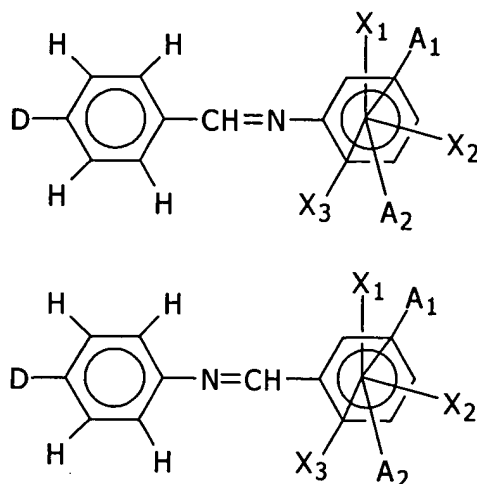
16 selected, and when A = $-\text{N}=\text{C}(\text{R}_1)(\text{R}_2)$, wherein $\text{R}_1 = \text{CF}_3$, C_2F_5 , $\text{C}_n\text{F}_{2n+1}$, $\text{R}_2 =$

17 H, CH_3 , CF_3 , C_2F_5 , then X_1 , X_2 , X_3 , X_4 are each independently selected from

18 the group -F and -H;

19

20 or second substituted imines,



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24 Wherein D = donor = $-\text{NH}_2$, $-\text{N}(\text{CH}_3)_2$, $-\text{N}(\text{CH}_2\text{CH}_3)_2$, or $-\text{N}(\text{Y})_2$ where Y =
 25 alkyl alcohols, alkyl (hydrocarbon or fluorocarbon) esters, or alkyl silane
 26 derivatives;

27

28 primary acceptor = $-\text{NO}_2$, $-\text{C}(\text{CN})\text{C}(\text{CN})_2$, or $-\text{N}=\text{C}(\text{R}_1)(\text{R}_2)$, where $\text{R}_1 =$
 29 CF_3 , C_2F_5 , $\text{C}_n\text{F}_{2n+1}$, $\text{R}_2 = \text{H}$, CH_3 , CF_3 , C_2F_5

30

31 secondary acceptor = $-\text{CN}$, or $-\text{CF}_3$

32

33 wherein if A₁ and A₂ are both primary acceptors selected from $-\text{NO}_2$, or
 34 $-\text{C}(\text{CN})\text{C}(\text{CN})_2$, then X₁, X₂, X₃ are each independently selected from -F and -
 35 H, but at least one -F must be selected;

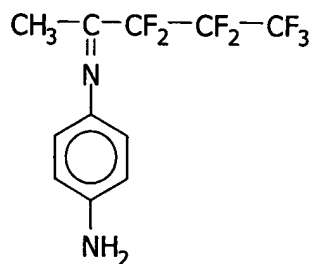
36 wherein if A₁ and A₂ are both secondary acceptors selected from $-\text{NO}_2$, or
 37 $-\text{C}(\text{CN})\text{C}(\text{CN})_2$, then X₁, X₂, X₃ are each independently selected from -F and -
 38 H, but at least one -F must be selected;

39 wherein if A₁ and/or A₂ are selected from the primary acceptor $-\text{N}=\text{C}$
 40 $(\text{R}_1)(\text{R}_2)$, where $\text{R}_1 = \text{CF}_3$, C_2F_5 , $\text{C}_n\text{F}_{2n+1}$, $\text{R}_2 = \text{H}$, CH_3 , CF_3 , C_2F_5 , then X₁, X₂, X₃
 41 are each independently selected from -F and -H; and

42 wherein if A₁ is selected from any primary acceptor, and A₂ is selected from
43 any secondary acceptor, then X₁, X₂, X₃ are each independently selected from
44 -F and -H.

1 21. The functional optical material according to Claim 16, wherein one of
2 said optically active chromophores comprises:

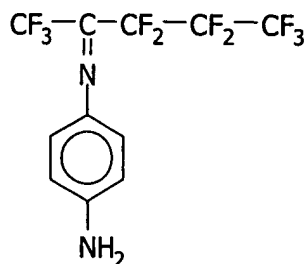
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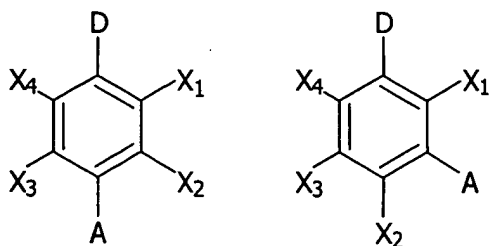
1 22. The functional optical material according to Claim 16, wherein one of
2 said optically active chromophores comprises:

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1 23. The functional optical material according to Claim 16, wherein said
2 compatibilizer has a nitrile group, and said one or more optically active
3 chromophores are selected from conventional substituted anilines comprising:



4

5 Wherein D = donor = $-\text{NH}_2$, $-\text{N}(\text{CH}_3)_2$, $-\text{N}(\text{CH}_2\text{CH}_3)_2$, or $-\text{N}(\text{Y})_2$ where Y =
6 alkyl alcohols, alkyl (hydrocarbon fluorocarbon) esters, or alkyl silane
7 derivatives;

8

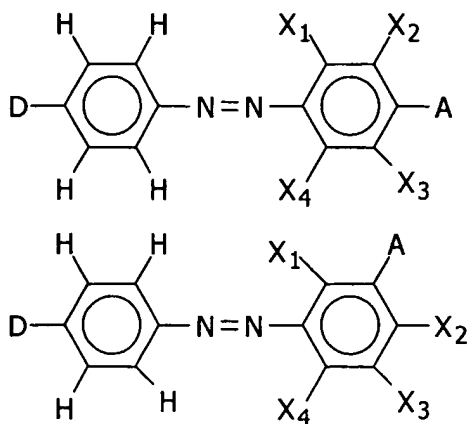
9 A = acceptor = $-\text{NO}_2$, or $-\text{C}(\text{CN})\text{C}(\text{CN})_2$, and

10

11 wherein X_1 , X_2 , X_3 , X_4 are each -H.

1 24. The functional optical material according to Claim 16, wherein said one
2 or more optically active chromophores is (are) selected from conventional
3 substituted azobenzenes comprising:

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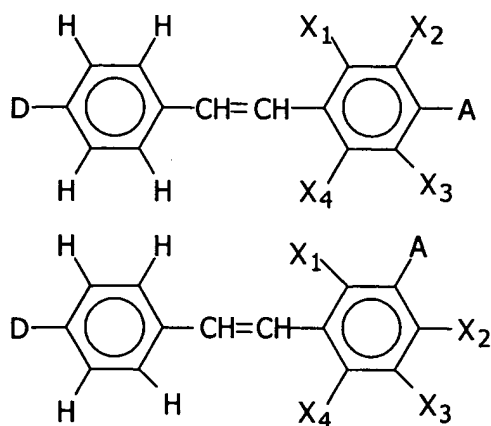


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6 Wherein D = donor = $-\text{NH}_2$, $-\text{N}(\text{CH}_3)_2$, $-\text{N}(\text{CH}_2\text{CH}_3)_2$, or $-\text{N}(\text{Y})_2$ where Y =
7 alkyl alcohols, alkyl (hydrocarbon fluorocarbon) esters, or alkyl silane
8 derivatives;

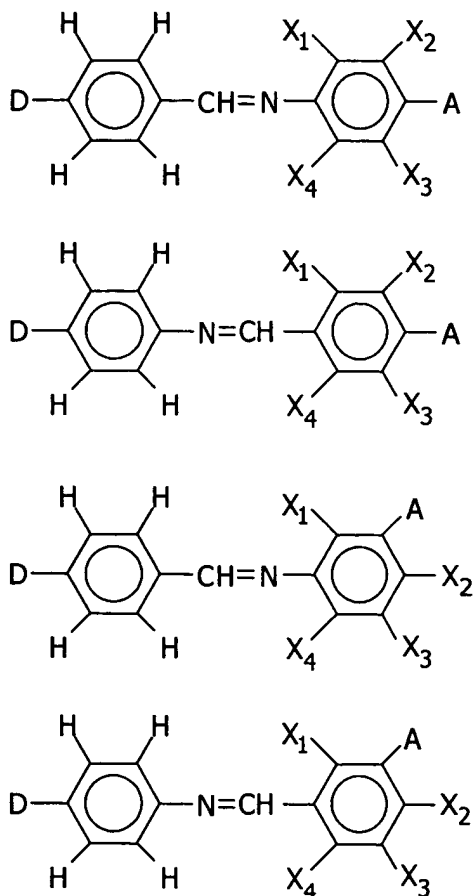
9
 10 A = acceptor = $-\text{NO}_2$, or $-\text{C}(\text{CN})\text{C}(\text{CN})_2$, and
 11
 12 wherein $\text{X}_1, \text{X}_2, \text{X}_3, \text{X}_4$ are each -H.

1 25. The functional optical material according to Claim 16, wherein said one
 2 or more optically active chromophores is (are) selected from conventional
 3 substituted stilbenes comprising:
 4



5
 6 Wherein D = donor = $-\text{NH}_2$, $-\text{N}(\text{CH}_3)_2$, $-\text{N}(\text{CH}_2\text{CH}_3)_2$, or $-\text{N}(\text{Y})_2$ where Y =
 7 alkyl alcohols, alkyl (hydrocarbon fluorocarbon) esters, or alkyl silane
 8 derivatives;
 9
 10 A = acceptor = $-\text{NO}_2$, or $-\text{C}(\text{CN})\text{C}(\text{CN})_2$, and
 11
 12 wherein $\text{X}_1, \text{X}_2, \text{X}_3, \text{X}_4$ are each -H.

1 26. The functional optical material according to Claim 16, wherein said one
 2 or more optically active chromophores is (are) selected from conventional
 3 substituted imines comprising:
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7 Wherein D = donor = $-\text{NH}_2$, $-\text{N}(\text{CH}_3)_2$, $-\text{N}(\text{CH}_2\text{CH}_3)_2$, or $-\text{N}(\text{Y})_2$ where Y =
 8 alkyl alcohols, alkyl (hydrocarbon fluorocarbon) esters, or alkyl silane
 9 derivatives;

10

11 A = acceptor = $-\text{NO}_2$, or $-\text{C}(\text{CN})\text{C}(\text{CN})_2$, and

12

13 wherein X_1 , X_2 , X_3 , X_4 are each $-\text{H}$.

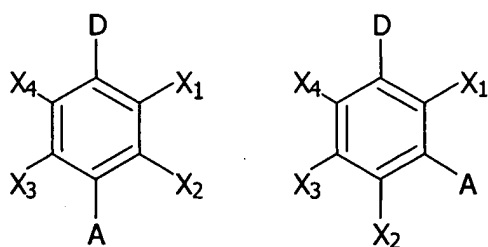
1 27. A functional optical material for use in an optical system, comprising:

2 (a) a polymer selected from the group comprising,

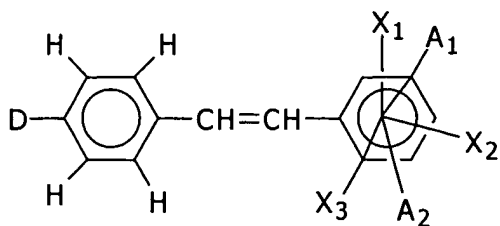
3 (1) a thermoplastic polymer;

4 (2) a thermosetting polymer; and

5 (3) a combination of thermoplastic and thermosetting polymers;
 6 wherein said thermoplastic and/or thermosetting polymers contain
 7 carbon-hydrogen and/or carbon-fluoride functionality; and
 8 (b) one or more optically active chromophores blended and/or copolymerized
 9 with said polymer, wherein said chromophore comprises:
 10 first substituted anilines



11
 12 Wherein D = donor = $-\text{NH}_2$, $-\text{N}(\text{CH}_3)_2$, $-\text{N}(\text{CH}_2\text{CH}_3)_2$, or $-\text{N}(\text{Y})_2$ where Y =
 13 alkyl alcohols, alkyl (hydrocarbon fluorocarbon) esters, or alkyl silane
 14 derivatives;
 15
 16 A = acceptor = $-\text{NO}_2$, $-\text{C}(\text{CN})\text{C}(\text{CN})_2$, or $-\text{N}=\text{C}(\text{R}_1)(\text{R}_2)$, wherein $\text{R}_1 = \text{CF}_3$,
 17 C_2F_5 , $\text{C}_n\text{F}_{2n+1}$, $\text{R}_2 = \text{H}$, CH_3 , CF_3 , C_2F_5
 18 wherein when A = $-\text{NO}_2$, or $-\text{C}(\text{CN})\text{C}(\text{CN})_2$, then X_1 , X_2 , X_3 , X_4 are each
 19 independently selected from the group -F and -H, and at least one -F is
 20 selected, and when A = $-\text{N}=\text{C}(\text{R}_1)(\text{R}_2)$, wherein $\text{R}_1 = \text{CF}_3$, C_2F_5 , $\text{C}_n\text{F}_{2n+1}$, $\text{R}_2 =$
 21 H , CH_3 , CF_3 , C_2F_5 , then X_1 , X_2 , X_3 , X_4 are each independently selected from
 22 the group -F and -H;
 23
 24 or second substituted anilines,

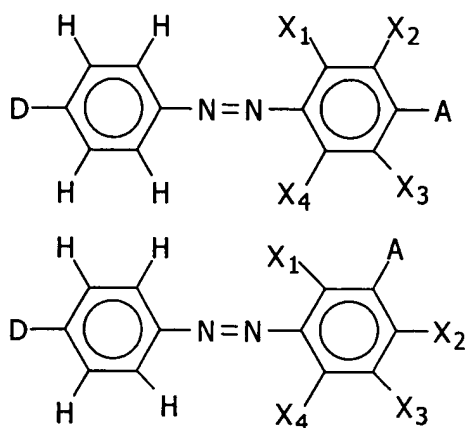


26

27 Wherein D = donor = $-\text{NH}_2$, $-\text{N}(\text{CH}_3)_2$, $-\text{N}(\text{CH}_2\text{CH}_3)_2$, or $-\text{N}(\text{Y})_2$ where Y =
 28 alkyl alcohols, alkyl (hydrocarbon or fluorocarbon) esters, or alkyl silane
 29 derivatives;
 30
 31 A_1 = primary acceptor = $-\text{NO}_2$, $-\text{C}(\text{CN})\text{C}(\text{CN})_2$, or $-\text{N}=\text{C}(\text{R}_1)(\text{R}_2)$, where
 32 $\text{R}_1 = \text{CF}_3$, C_2F_5 , $\text{C}_n\text{F}_{2n+1}$, $\text{R}_2 = \text{H}$, CH_3 , CF_3 , C_2F_5
 33
 34 A_2 = secondary acceptor = $-\text{CN}$, or $-\text{CF}_3$
 35
 36 wherein X_1 , X_2 , X_3 are each independently selected from the group -F and -H;
 37
 38 and wherein A_1 can be the same as A_2 , wherein two identical or different
 39 acceptors may be selected from group A_1 or two identical or different
 40 acceptors may be selected from group A_2 , so that when acceptors are
 41 selected from $-\text{NO}_2$, $-\text{C}(\text{CN})\text{C}(\text{CN})_2$, $-\text{CN}$, or $-\text{CF}_3$, then X_1 , X_2 , X_3 are each
 42 independently selected from the group -F and -H, and at least one -F is
 43 selected; and if at least one acceptor is selected as $-\text{N}=\text{C}(\text{R}_1)(\text{R}_2)$, where
 44 $\text{R}_1 = \text{CF}_3$, C_2F_5 , $\text{C}_n\text{F}_{2n+1}$, $\text{R}_2 = \text{H}$, CH_3 , CF_3 , C_2F_5 , then X_1 , X_2 , X_3 are each
 45 independently selected from the group -F and -H.

- 1 28. A functional optical material for use in an optical system, comprising:
 2 (a) a polymer selected from the group comprising,
 3 (1) a thermoplastic polymer;
 4 (2) a thermosetting polymer; and
 5 (3) a combination of thermoplastic and thermosetting polymers;
 6 wherein said thermoplastic and/or thermosetting polymers contain
 7 carbon-hydrogen and/or carbon-fluoride functionality; and
 8 (b) one or more optically active chromophores blended and/or copolymerized
 9 with said polymer, wherein said chromophore comprises:

10 first substituted azobenzenes



11

12 Wherein D = donor = $-\text{NH}_2$, $-\text{N}(\text{CH}_3)_2$, $-\text{N}(\text{CH}_2\text{CH}_3)_2$, or $-\text{N}(\text{Y})_2$ where Y =
13 alkyl alcohols, alkyl (hydrocarbon fluorocarbon) esters, or alkyl silane
14 derivatives;

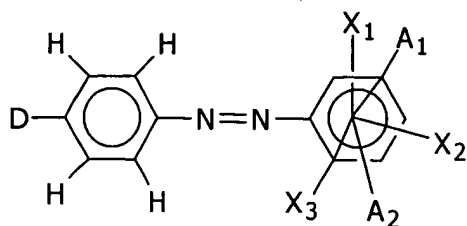
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16 A = acceptor = $-\text{NO}_2$, $-\text{C}(\text{CN})\text{C}(\text{CN})_2$, or $-\text{N}=\text{C}(\text{R}_1)(\text{R}_2)$, wherein $\text{R}_1 = \text{CF}_3$,
17 C_2F_5 , $\text{C}_n\text{F}_{2n+1}$, $\text{R}_2 = \text{H}$, CH_3 , CF_3 , C_2F_5
18 wherein when $\text{A} = -\text{NO}_2$, or $-\text{C}(\text{CN})\text{C}(\text{CN})_2$, then $\text{X}_1, \text{X}_2, \text{X}_3, \text{X}_4$ are each
19 independently selected from the group -F and -H, and at least one -F is
20 selected, and when $\text{A} = -\text{N}=\text{C}(\text{R}_1)(\text{R}_2)$, wherein $\text{R}_1 = \text{CF}_3$, C_2F_5 , $\text{C}_n\text{F}_{2n+1}$, $\text{R}_2 =$
21 H , CH_3 , CF_3 , C_2F_5 , then $\text{X}_1, \text{X}_2, \text{X}_3, \text{X}_4$ are each independently selected from
22 the group -F and -H;

23

24 or second substituted azobenzenes,

25

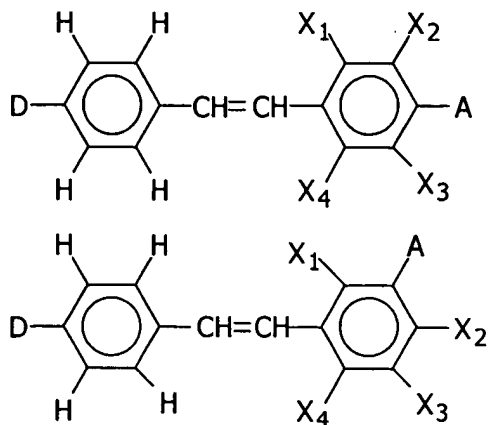


26

27 Wherein D = donor = $-\text{NH}_2$, $-\text{N}(\text{CH}_3)_2$, $-\text{N}(\text{CH}_2\text{CH}_3)_2$, or $-\text{N}(\text{Y})_2$ where Y =
 28 alkyl alcohols, alkyl (hydrocarbon or fluorocarbon) esters, or alkyl silane
 29 derivatives;
 30
 31 primary acceptor = $-\text{NO}_2$, $-\text{C}(\text{CN})\text{C}(\text{CN})_2$, or $-\text{N}=\text{C}(\text{R}_1)(\text{R}_2)$, where $\text{R}_1 =$
 32 CF_3 , C_2F_5 , $\text{C}_n\text{F}_{2n+1}$, $\text{R}_2 = \text{H}$, CH_3 , CF_3 , C_2F_5
 33
 34 secondary acceptor = $-\text{CN}$, or $-\text{CF}_3$
 35
 36 wherein if A_1 and A_2 are both primary acceptors selected from $-\text{NO}_2$, or
 37 $-\text{C}(\text{CN})\text{C}(\text{CN})_2$, then X_1 , X_2 , X_3 are each independently selected from $-\text{F}$ and $-\text{H}$,
 38 but at least one $-\text{F}$ must be selected;
 39 wherein if A_1 and A_2 are both secondary acceptors selected from $-\text{NO}_2$, or
 40 $-\text{C}(\text{CN})\text{C}(\text{CN})_2$, then X_1 , X_2 , X_3 are each independently selected from $-\text{F}$ and $-\text{H}$,
 41 but at least one $-\text{F}$ must be selected;
 42 wherein if A_1 and/or A_2 are selected from the primary acceptor $-\text{N}=\text{C}$
 43 $(\text{R}_1)(\text{R}_2)$, where $\text{R}_1 = \text{CF}_3$, C_2F_5 , $\text{C}_n\text{F}_{2n+1}$, $\text{R}_2 = \text{H}$, CH_3 , CF_3 , C_2F_5 , then X_1 , X_2 , X_3
 44 are each independently selected from $-\text{F}$ and $-\text{H}$; and
 45 wherein if A_1 is selected from any primary acceptor, and A_2 is selected from
 46 any secondary acceptor, then X_1 , X_2 , X_3 are each independently selected from
 47 $-\text{F}$ and $-\text{H}$.

1 29. A functional optical material for use in an optical system, comprising:
 2 (a) a polymer selected from the group comprising,
 3 (1) a thermoplastic polymer;
 4 (2) a thermosetting polymer; and
 5 (3) a combination of thermoplastic and thermosetting polymers;
 6 wherein said thermoplastic and/or thermosetting polymers contain
 7 carbon-hydrogen and/or carbon-fluoride functionality; and
 8 (b) one or more optically active chromophores blended and/or copolymerized
 9 with said polymer, wherein said chromophore comprises:
 10 first substituted stilbenes

11



12

13

14 Wherein D = donor = $-\text{NH}_2$, $-\text{N}(\text{CH}_3)_2$, $-\text{N}(\text{CH}_2\text{CH}_3)_2$, or $-\text{N}(\text{Y})_2$ where Y =
 15 alkyl alcohols, alkyl (hydrocarbon fluorocarbon) esters, or alkyl silane
 16 derivatives;

17

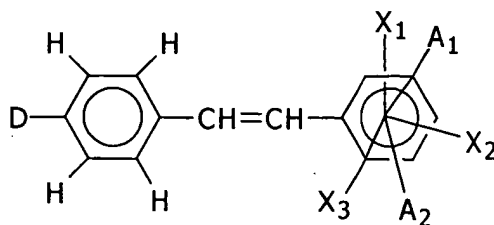
18 A = acceptor = $-\text{NO}_2$, $-\text{C}(\text{CN})\text{C}(\text{CN})_2$, or $-\text{N}=\text{C}(\text{R}_1)(\text{R}_2)$, wherein $\text{R}_1 = \text{CF}_3$,
 19 C_2F_5 , $\text{C}_n\text{F}_{2n+1}$, $\text{R}_2 = \text{H}$, CH_3 , CF_3 , C_2F_5

20 wherein when A = $-\text{NO}_2$, or $-\text{C}(\text{CN})\text{C}(\text{CN})_2$, then X₁, X₂, X₃, X₄ are each
 21 independently selected from the group -F and -H, and at least one -F is
 22 selected, and when A = $-\text{N}=\text{C}(\text{R}_1)(\text{R}_2)$, wherein $\text{R}_1 = \text{CF}_3$, C_2F_5 , $\text{C}_n\text{F}_{2n+1}$, $\text{R}_2 =$
 23 H , CH_3 , CF_3 , C_2F_5 , then X₁, X₂, X₃, X₄ are each independently selected from
 24 the group -F and -H;

25

26 or second substituted stilbenes,

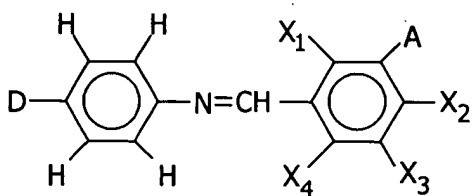
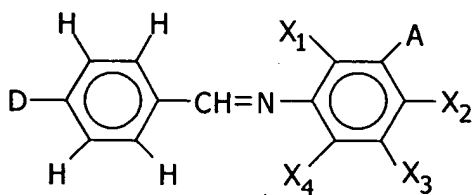
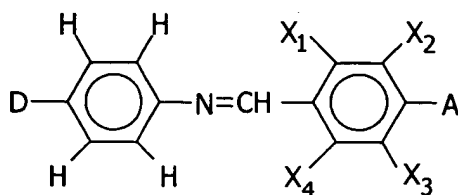
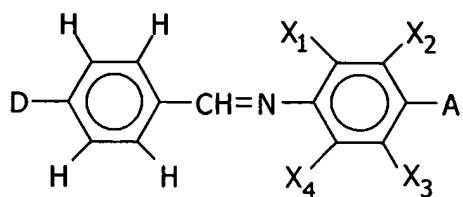
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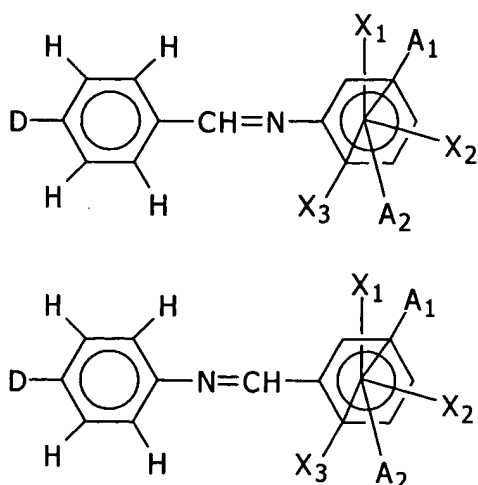
28

29 Wherein D = donor = $-\text{NH}_2$, $-\text{N}(\text{CH}_3)_2$, $-\text{N}(\text{CH}_2\text{CH}_3)_2$, or $-\text{N}(\text{Y})_2$ where Y =
 30 alkyl alcohols, alkyl (hydrocarbon or fluorocarbon) esters, or alkyl silane
 31 derivatives;
 32
 33 primary acceptor = $-\text{NO}_2$, $-\text{C}(\text{CN})\text{C}(\text{CN})_2$, or $-\text{N}=\text{C}(\text{R}_1)(\text{R}_2)$, where $\text{R}_1 =$
 34 CF_3 , C_2F_5 , $\text{C}_n\text{F}_{2n+1}$, $\text{R}_2 = \text{H}$, CH_3 , CF_3 , C_2F_5
 35
 36 secondary acceptor = $-\text{CN}$, or $-\text{CF}_3$
 37
 38 wherein if A_1 and A_2 are both primary acceptors selected from $-\text{NO}_2$, or
 39 $-\text{C}(\text{CN})\text{C}(\text{CN})_2$, then X_1 , X_2 , X_3 are each independently selected from -F and -
 40 H, but at least one -F must be selected;
 41 wherein if A_1 and A_2 are both secondary acceptors selected from $-\text{NO}_2$, or
 42 $-\text{C}(\text{CN})\text{C}(\text{CN})_2$, then X_1 , X_2 , X_3 are each independently selected from -F and -
 43 H, but at least one -F must be selected;
 44 wherein if A_1 and/or A_2 are selected from the primary acceptor $-\text{N}=\text{C}$
 45 $(\text{R}_1)(\text{R}_2)$, where $\text{R}_1 = \text{CF}_3$, C_2F_5 , $\text{C}_n\text{F}_{2n+1}$, $\text{R}_2 = \text{H}$, CH_3 , CF_3 , C_2F_5 , then X_1 , X_2 , X_3
 46 are each independently selected from -F and -H; and
 47 wherein if A_1 is selected from any primary acceptor, and A_2 is selected from
 48 any secondary acceptor, then X_1 , X_2 , X_3 are each independently selected from
 49 -F and -H.

1 30. A functional optical material for use in an optical system, comprising:
 2 (a) a polymer selected from the group comprising,
 3 (1) a thermoplastic polymer;
 4 (2) a thermosetting polymer; and
 5 (3) a combination of thermoplastic and thermosetting polymers;
 6 wherein said thermoplastic and/or thermosetting polymers contain
 7 carbon-hydrogen and/or carbon-fluoride functionality; and
 8 (b) one or more optically active chromophores blended and/or copolymerized
 9 with said polymer, wherein said chromophore comprises:
 10 first substituted imines,

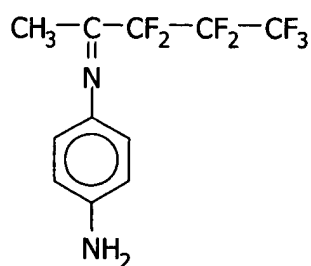


- 11
- 12 Wherein D = donor = $-\text{NH}_2$, $-\text{N}(\text{CH}_3)_2$, $-\text{N}(\text{CH}_2\text{CH}_3)_2$, or $-\text{N}(\text{Y})_2$ where Y =
- 13 alkyl alcohols, alkyl (hydrocarbon fluorocarbon) esters, or alkyl silane
- 14 derivatives;
- 15
- 16 A = acceptor = $-\text{NO}_2$, $-\text{C}(\text{CN})\text{C}(\text{CN})_2$, or $-\text{N}=\text{C}(\text{R}_1)(\text{R}_2)$, wherein $\text{R}_1 = \text{CF}_3$,
- 17 C_2F_5 , $\text{C}_n\text{F}_{2n+1}$, $\text{R}_2 = \text{H}$, CH_3 , CF_3 , C_2F_5
- 18 wherein when A = $-\text{NO}_2$, or $-\text{C}(\text{CN})\text{C}(\text{CN})_2$, then X_1 , X_2 , X_3 , X_4 are each
- 19 independently selected from the group -F and -H, and at least one -F is
- 20 selected, and when A = $-\text{N}=\text{C}(\text{R}_1)(\text{R}_2)$, wherein $\text{R}_1 = \text{CF}_3$, C_2F_5 , $\text{C}_n\text{F}_{2n+1}$, $\text{R}_2 =$
- 21 H , CH_3 , CF_3 , C_2F_5 , then X_1 , X_2 , X_3 , X_4 are each independently selected from
- 22 the group -F and -H;
- 23
- 24 or second substituted imines,
- 25

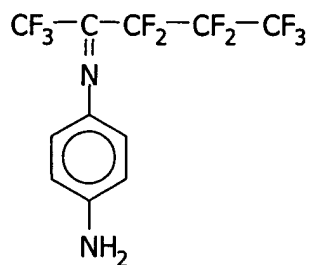


- 26
- 27 Wherein D = donor = $-\text{NH}_2$, $-\text{N}(\text{CH}_3)_2$, $-\text{N}(\text{CH}_2\text{CH}_3)_2$, or $-\text{N}(\text{Y})_2$ where Y =
- 28 alkyl alcohols, alkyl (hydrocarbon or fluorocarbon) esters, or alkyl silane
- 29 derivatives;
- 30
- 31 primary acceptor = $-\text{NO}_2$, $-\text{C}(\text{CN})\text{C}(\text{CN})_2$, or $-\text{N}=\text{C}(\text{R}_1)(\text{R}_2)$, where $\text{R}_1 =$
- 32 CF_3 , C_2F_5 , $\text{C}_n\text{F}_{2n+1}$, $\text{R}_2 = \text{H}$, CH_3 , CF_3 , C_2F_5
- 33
- 34 secondary acceptor = $-\text{CN}$, or $-\text{CF}_3$
- 35
- 36 wherein if A_1 and A_2 are both primary acceptors selected from $-\text{NO}_2$, or
- 37 $-\text{C}(\text{CN})\text{C}(\text{CN})_2$, then X_1 , X_2 , X_3 are each independently selected from -F and -
- 38 H, but at least one -F must be selected;
- 39 wherein if A_1 and A_2 are both secondary acceptors selected from $-\text{NO}_2$, or
- 40 $-\text{C}(\text{CN})\text{C}(\text{CN})_2$, then X_1 , X_2 , X_3 are each independently selected from -F and -
- 41 H, but at least one -F must be selected;
- 42 wherein if A_1 and/or A_2 are selected from the primary acceptor $-\text{N}=\text{C}$
- 43 $(\text{R}_1)(\text{R}_2)$, where $\text{R}_1 = \text{CF}_3$, C_2F_5 , $\text{C}_n\text{F}_{2n+1}$, $\text{R}_2 = \text{H}$, CH_3 , CF_3 , C_2F_5 , then X_1 , X_2 , X_3
- 44 are each independently selected from -F and -H; and
- 45 wherein if A_1 is selected from any primary acceptor, and A_2 is selected from
- 46 any secondary acceptor, then X_1 , X_2 , X_3 are each independently selected from
- 47 -F and -H.

- 1 31. A functional optical material for use in an optical system, comprising:
 2 (a) a polymer selected from the group comprising,
 3 (1) a thermoplastic polymer;
 4 (2) a thermosetting polymer; and
 5 (3) a combination of thermoplastic and thermosetting polymers;
 6 wherein said thermoplastic and/or thermosetting polymers contain
 7 carbon-hydrogen and/or carbon-fluoride functionality; and
 8 (b) one or more optically active chromophores blended and/or copolymerized
 9 with said polymer, wherein at least one chromophore comprises:



- 1 32. A functional optical material for use in an optical system, comprising:
 2 (a) a polymer selected from the group comprising,
 3 (1) a thermoplastic polymer;
 4 (2) a thermosetting polymer; and
 5 (3) a combination of thermoplastic and thermosetting polymers;
 6 wherein said thermoplastic and/or thermosetting polymers contain
 7 carbon-hydrogen and/or carbon-fluoride functionality; and
 8 (b) one or more optically active chromophores blended and/or copolymerized
 9 with said polymer, wherein at least one chromophore comprises:



1 33. A functional optical material useful in an optical system comprising: a
2 polymer of
3 (a) one or more partially or fully fluorinated first monomer(s) having a
4 refractive index of less than about 1.5, or wherein a homopolymer formed
5 from said first monomer(s) has a refractive index of less than about 1.5;
6 (b) zero, one, or more second monomer(s) having a refractive index ≥ 1.5 , or
7 wherein a homopolymer formed from said second monomer(s) has a
8 refractive index ≥ 1.5 ;
9 (c) at least one optically active chromophore;
10 (d) at least one compatibilizer for said optically active chromophore;
11 (e) at least one adhesion promoter, having one or more pendant groups
12 selected from the group consisting of nitriles, silanes, fluorinated silanes,
13 organic acids; fluorinated organic acids, alcohols, fluorinated alcohols, amides,
14 and amines; wherein when a compatibilizer with one particular pendant group
15 is selected, an adhesion promoter with a different pendant group is selected.

1 34. A method of forming a functional optical material comprising:
2 A. determining if a low index of refraction material ($n < 1.5$) or high index of
3 refraction material ($n \geq 1.5$) is desired,
4 B. for a low refractive index optical material
5 (1) selecting one or more monomers having a low index of refraction;
6 (2) selecting zero, one, or more monomers having a high index of
7 refraction, wherein the concentration of the monomer(s) with a high
8 index of refraction is less than the concentration of monomer(s) having
9 a low index of refraction;
10 (3) selecting zero, one or more optically active chromophores;
11 (4) selecting zero, one, or more of conventional optical chromophores ,
12 with the proviso that at least one chromophore must be selected;
13 (5) selecting one or more compatibilizers for the selected
14 chromophore(s), having one or more pendant groups selected from the
15 group consisting of nitriles, esters, aromatics; fluorinated esters, and
16 fluorinated aromatics; and

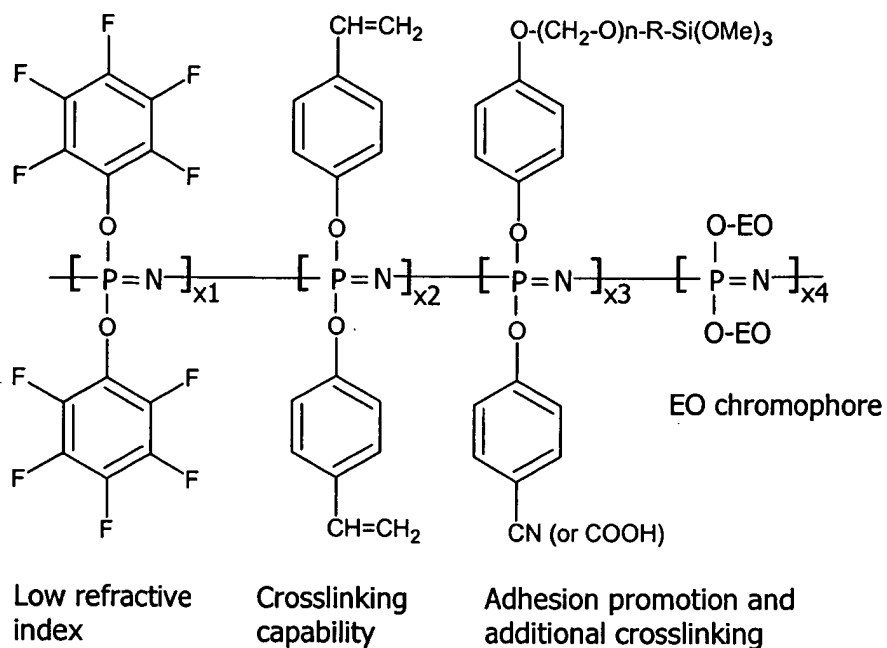
17 (6) selecting one or more adhesion enhancers, having one or more
18 pendant groups selected from the group consisting of nitriles, silanes,
19 fluorinated silanes, organic acids; fluorinated organic acids, alcohols,
20 fluorinated alcohols, amides, and amines; wherein when a
21 compatibilizer with one particular pendant group is selected, an
22 adhesion promoter with a different pendant group is selected; and
23 (7) mixing and reacting said selected monomer(s), chromophore(s),
24 compatibilizer, and adhesion enhancer.

25 C. for a high refractive index optical material

26 (1) selecting one or more monomers having a high index of refraction;
27 (2) selecting zero, one, or more monomers having a low index of
28 refraction, wherein the concentration of the monomer(s) with a low
29 index of refraction is less than the concentration of monomer(s) having
30 a high index of refraction;
31 (3) selecting zero, one or more optically active chromophores;
32 (4) selecting zero, one, or more of conventional optical chromophores ,
33 with the proviso that at least one chromophore must be selected;
34 (5) selecting one or more compatibilizers for the selected
35 chromophore(s), having one or more pendant groups selected from the
36 group consisting of nitriles, esters, aromatics; fluorinated esters, and
37 fluorinated aromatics; and
38 (6) selecting one or more adhesion enhancers, having one or more
39 pendant groups selected from the group consisting of nitriles, silanes,
40 fluorinated silanes, organic acids ????; fluorinated organic acids,
41 alcohols, fluorinated alcohols, amides, and amines; wherein when a
42 compatibilizer with one particular pendant group is selected, an
43 adhesion promoter with a different pendant group is selected; and
44 (7) mixing and reacting said selected monomer(s), chromophore(s),
45 compatibilizer, and adhesion enhancer.

1 35. The method according to Claim 34, wherein high T_g materials are
 2 prepared by selecting and reacting fluorinated monomers with nonfluorinated
 3 monomers.

1 36. A functional optical material for use in an optical system comprising:



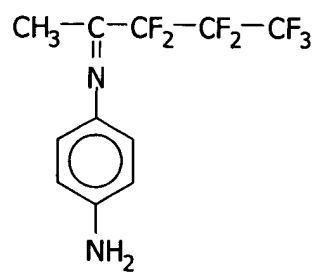
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4 wherein $x_1 = 50 - 80$ wt.%, $x_2 = 10 - 15$ wt.%, $x_3 = 1 - 5$ wt.%, $x_4 = 5$
 5 $- 20$ wt.%

6 and wherein one or more of said -F atoms may be substituted by an -H atom.

- 1 37. A compound comprising:



2

38. A compound comprising:

